A Tuned Active Antenna

The modern home tends to have a smaller garden which is insufficiently large to put up a good wire antenna for the lower h.f. bands. This could be a disadvantage to anyone living in these circumstances, but now this very effective tuneable active antenna from Adrian Knott G6KSN changes all that. It should prove more than adequate for even the tiniest of flats, and choice of frequencies covered would also prove very useful at holidays locations.

Whilst many of us possess communications receivers and listen to the h.f. bands, be it amateur, commercial, or broadcast stations, unfortunately we do not all have sufficient space to string up a nest of dipoles cut to our favourite bands, particularly if these happen to include Top Band or some of the lower marine or aeronautical allocations. Thus, it seemed to be a good idea to me that an antenna of small physical size, but with the performance comparable of the full sized dipole could be constructed.

Initial experiments using a short whip feeding into a source follower, then into a one or two transistor amplifier, were disappointing on the lower frequency ranges. This was especially true on topband where swamping and cross modulation from m.w. broadcast stations masked all but the strongest signals. Subsequent investigation revealed that non-linearity in the front-end f.e.t., was the major cause of the problem. Tuning the input stage removed these problems at a stroke. Navigation beacons on topband became audible during the afternoon, suggesting a very respectable sensitivity. A further improvement is achieved by mounting the antenna remotely and feeding the receiver via a coaxial line. It was for these reasons that a remote tuning system was developed along with an indoor power supply and switchable attenuator unit.

Mast-head Unit

The circuit diagram of the remote head unit is shown in Fig. 1. This remote unit may be constructed to cover various portions of the h.f. band, and L1 should be chosen from the range of approximate values shown in Table 1 later in the project, to resonate with Varicap diode D5 over the required band. A short whip antenna is fed to the gate of the f.e.t. TR1., which has protection diodes D1-D4 between the gate and the 0V line. Coil L1, in conjunction with Varicap D5 form the input tuning circuit. The tuning voltage for D5 is filtered by the CR network C3, R2 and C2, then passed via the isolating resistor R1 to the cathode of D5.

The decoupling of source resistor R3 by capacitor C4 provides a degree of gain with TR1, the output of which is fed through blocking capacitor C5 to the wide band amplifier made up of TR2 and TR3. This amplifier has a gain which remains substantially constant over the whole h.f. band and provides a good match to the coaxial line conveying the signal to the indoor unit. The 15V power supply line is filtered and decoupled by capacitors C7 and 8 to reduce noise and power lead pick-up. These capacitors may be omitted if the whole system is built in one metal box, but must be included if the antenna is remote to the power supply unit.

Construction and Technique

On the prototype boards, components were mounted on the copper side of the board, as shown in Fig. 4a and 4b. The isolated areas for items were produced by cutting the copper away to form 'islands' in the correct places. This, by the way, was an early form of surface mounting practiced by many home constructors.

Indoor Unit

Shown in Fig. 2 is the mains p.s.u. and tuning control unit. Transformer T1 is a small 15V 100mA double insulated type with the secondary output going to the diode bridge made up of diodes D6 -D9. Entry of r.f. interference at this point is minimised by paralleling each diode with a capacitor (C9-C12). An l.e.d. D10 and its limiting resistor R9 give a visual indication that the unit is switched on. After filtering by C13 the output voltage is stabilised using a single low power 15V regulator i.c. IC1. An occasional problem with these i.c.s is a tendency to oscillate at a low v.h.f. frequency. These tendencies are counteracted by capacitors C14 and 15, which should be mounted as close as possible to the i.c., preferably using the minimum lead length. Capacitor C16 provides further hum and noise reduction. Tuning control R10 picks off a portion of the 15V rail and passes this to the remote unit tuning voltage filter mentioned earlier.

At times a degree of signal attenuation will improve reception quality, and so two switched attenuator pads have been implemented as shown in Fig. 3a. Switch S1 controls a combination of resistors R11 to 13 which form a 10dB pad whilst maintaining a constant impedance close to 50Ω. Similarly S2 and its associated resistors form a 20dB attenuator pad. These attenuators are not to be taken as exact, but have been calculated and the nearest preferred resistor values been used. The layout of the attenuator switches, which should be mounted as close together as

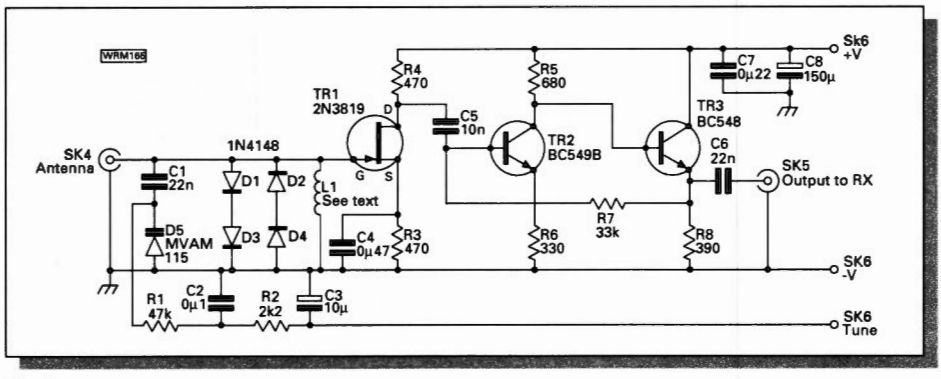


Fig.1

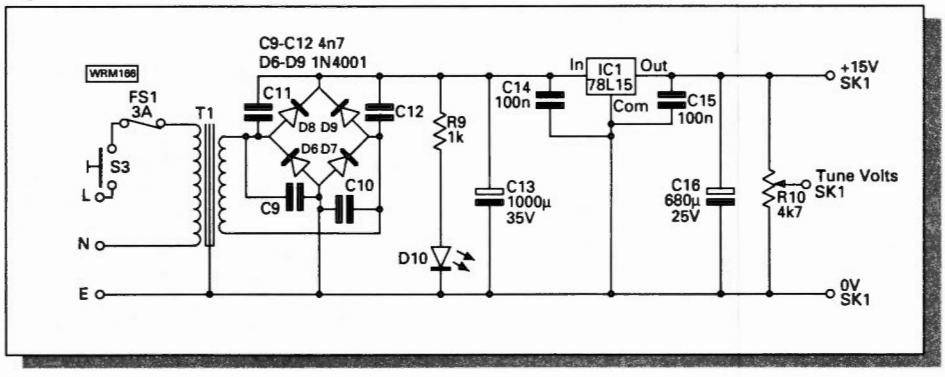
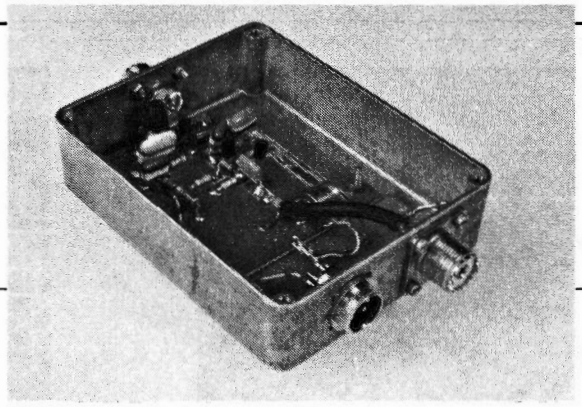


Fig.2



The mast-head unit mounted in its die-cast box

possible using screened coaxial lead for input and output connections, is shown in Fig. 3b.

Testing

Construct the p.s.u. board of the indoor unit and assemble the rest of the unit, but do not connect the output lines at this point. Check that the mains fuse is no greater than 3A, and that the mains connections are safely connected and insulated where appropriate. Finally check that all components are in their correct position and orientation. Switch the unit on and with a multimeter set to read 25V d.c. full scale, measure the voltage across C13. This should be in the region of 20 - 23V, and the l.e.d. D10 should illuminate. Transferring the leads of the meter across C16 to measure the voltage, should result in a reading of 14.5V to 15.5V. If this is the case then measure the voltage available on the slider of R10. It should be possible to obtain a voltage which may be varied between 0V and the voltage across C16.

When all is well, connect the negative side of the power supply to one of the pins of the output socket SK1 and the positive connection to another of the pins. The tune voltage is connected to a third pin. Matching the pins used, solder the control cable conductors to the plug. As the connections are made take note of the colour of the wires and what voltages they carry, this will be needed later.

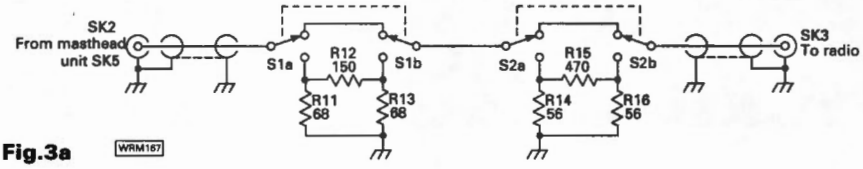


Fig.3a

WRM167

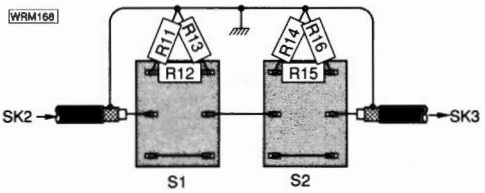


Fig.3b

Construct the remote mast-head unit, taking care to use the correct islands and to orientate the components correctly. At this point the working position of this remote unit must be decided, as the positioning of the various sockets depends on this. In the prototype the antenna was at one end, with the output, SK5, and control,SK6, sockets at the opposite end to exit vertically downwards in normal use. Drill the box and mount the sockets in the correct positions. Using the colour scheme noted when wiring the indoor unit, solder the remote end plug to the control cable, and make note of the pins used at this end. From the

Shopping list

Resistors

0.25W 5% Carbon film

56Ω	2	R14,16
68Ω	2	R11,13
150Ω	1	R12
330Ω	1	R6
390Ω	1	R8
470Ω	3	R3,4,15
680Ω	1	R5
1kΩ	1	R9
2.2kΩ	1	R2
33kΩ	1	R7
47kΩ	1	R1

Potentiometer lin. rotary

4.7kΩ	1	R10

(5kΩ more usual in catalogues)

Capacitors

Disc ceramic

4.7nF	4	C9-12
10nF	1	C5
22nF	2	C1,6
100nF	3	C2,14,15

Miniature polyester 100V

220nF	1	C7
470nF	1	C4

Electrolytic axial leads 25v working

10µF	1	C3
150µF	1	C8
680µF	1	C16

Electrolytic axial leads 35V working

1000µF	1	C13

Inductors see text and Table 1.

Semiconductors

Transistors

BC548	1	TR3
BC549B	1	TR2
2N3819	1	TR1

Integrated Circuits

78L15	1	IC1.

(low power 15V regulator i.c.)

Diodes

l.e.d	1	D10 (colour of choice)
MVAM115	1	D5 (27-560pF Varicap)
1N4001	4	D6-9
1N4148	4	D1-4

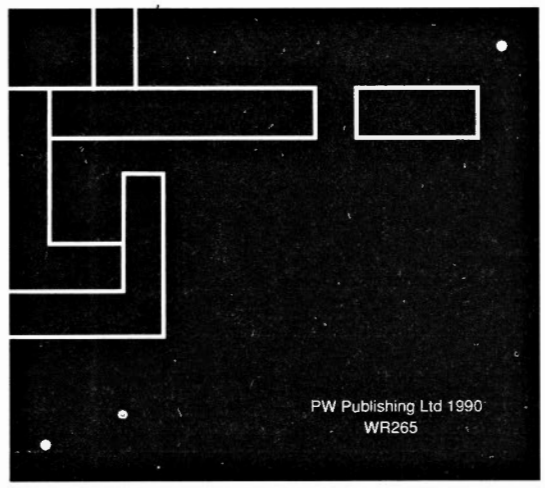
Miscellaneous

15V 100mA transformer; 3A fuse and chassis mounted fuse holder; low power three core mains cable; Mains on/off switch; 2 x 2 pole miniature change over switches; Diecast aluminium box 121 x 95 x 29mm for the remote head unit; Suitable aluminium box, approximately 150 x 120 x 50mm, for the main indoor unit; Coaxial plugs and sockets plus coaxial cable; two pairs of plugs & sockets, plus lightweight 3 core control cable; Single strand connecting wire of various colours; Suitable knob for the tuning control.

Inductance	f minimum (MHz)	f maximum (MHz)
1.0µH	7.12	30.63
1.2µH	6.50	27.96
1.5µH	5.81	25.01
1.8µH	5.31	22.83
2.2µH	4.80	20.65
2.7µH	4.33	18.64
3.3µH	3.92	16.86
3.9µH	3.60	15.51
4.7µH	3.28	14.13
5.6µH	3.01	12.94
6.8µH	2.73	11.75
8.2µH	2.49	10.70
10.0µH	2.25	9.69
12.0µH	2.05	8.84
15.0µH	1.84	7.91
18.0µH	1.68	7.22
22.0µH	1.52	6.53
27.0µH	1.37	5.89
33.0µH	1.24	5.33
39.0µH	1.14	4.90
47.0µH	1.04	4.47

Table 1.

HOW MUCH ?
£ 35.00
HOW DIFFICULT
Intermediate



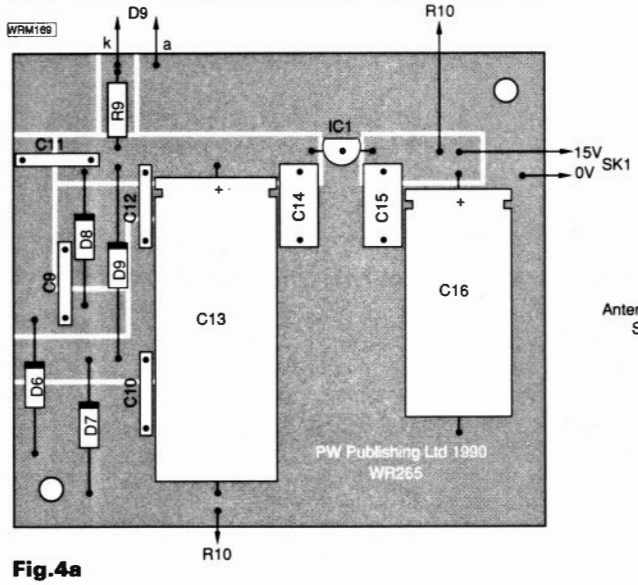
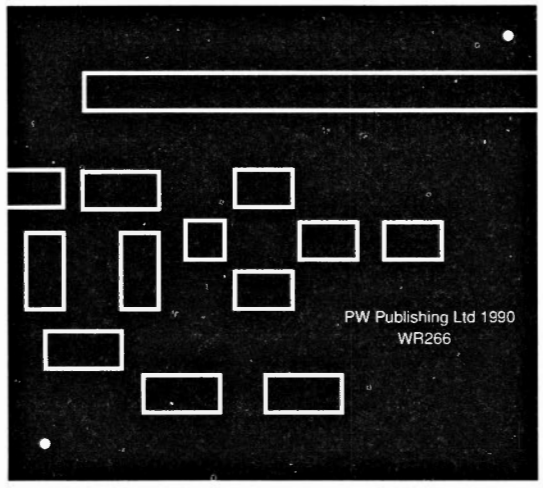


Fig.4a



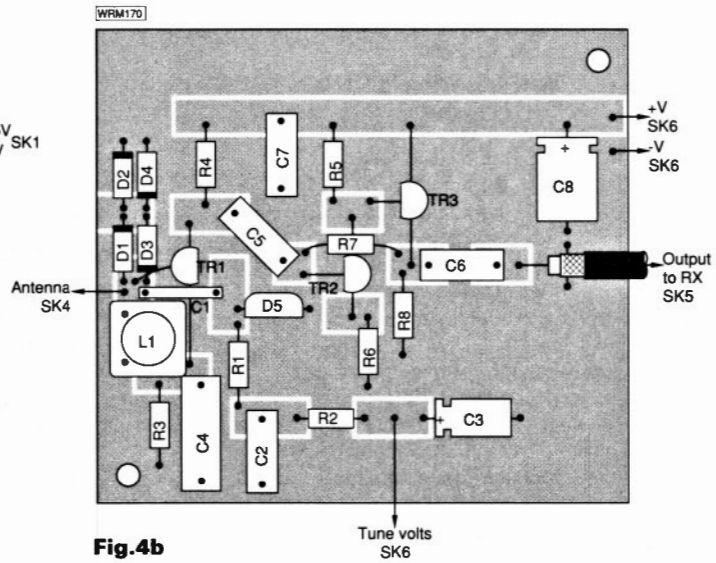


Fig.4b

corresponding pins of the socket, connect the 0V line to area marked -V in Fig. 4b and the 15V line to the land marked +V in the same diagram. Finally connect the tune volts line to the land on the positive side of C3.

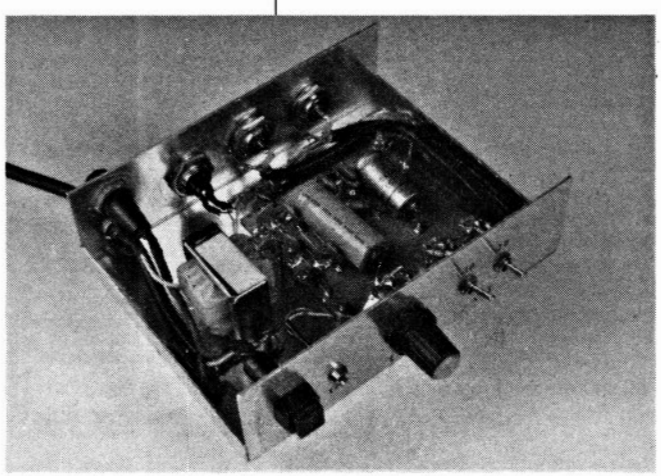
Carefully check all connections, components and orientations, and, if all is as it should be, connect the remote masthead unit to the indoor unit using the control cable. Monitor the voltage across C3 in the remote unit, it should be the same as the output voltage from the p.s.u. Also check the tune volts line in the remote unit, this should slowly follow the movement of the wiper of R10, and be variable between both supply rail limits. If this is not the case switch off and recheck all the connections.

Assuming that all is well then connect the short antenna to socket SK4 and the remote unit to the input of the attenuator pads via a suitable length of coaxial cable. The output from the attenuators should be connected, via a second piece of coaxial cable, to a communications receiver. Tune the receiver to the low end of the band of interest and set the tune volts to minimum. Noting the level of noise on the receiver, slowly rotate R10 to increase the tune voltage. The level of noise should peak and then decrease as the remote unit is tuned towards the higher frequencies. Retune the receiver to about twice its original frequency setting and retune the remote unit to peak the noise or signal level again.

At this point check the operation of the attenuators. Tune to a fairly strong constant signal, and operate both switches individually. If the receiver has a signal strength meter, an indication of their action should be obvious. However if no meter is fitted, a slight change in audio output may be the only indication of the attenuators coming into circuit.

Retune both the receiver and the remote unit to discover the upper and lower limits of coverage of the system. The frequencies at the both ends will vary with temperature, so if the band of interest is to be found at an extreme end, the next inductance value up or down should be chosen to place the required frequency towards the centre of tuning.

The combined indoor power and remote tuning unit



In Use

In use the antenna has been found to give impressive results on very weak stations, but at the same time copes very well with the end-stopping signals of the 6MHz band without signs of overload or cross modulation. This antenna has proved invaluable to the author and it is hoped that it may be of interest to others where space is at a premium. **PW**